Independent Faculty Research

PROMPT GLOBAL STRIKE: CHINA AND THE SPEAR

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Key Themes

- A close examination of Chinese scientific journals reveals emerging perspectives on prompt global strike (PGS). As Chinese official defense white papers have become shorter in length, technical journals provide a clearer window into threat perceptions and direction of Chinese military modernization. They reveal that technical and military institutes in China are conducting substantial research into both countering and developing hypersonic, precision-guidance, and boost-glide technologies. The amount of this research dwarfs that heretofore available on their ballistic missile defense (BMD)-related technologies. In contrast to BMD, Chinese PGS-oriented literature combines scientific and strategic details, reflecting a broader shift to integrate strategic departments into its technical institutes.

- Chinese analysts view PGS as part of a larger U.S. effort to achieve "absolute security," with BMD as the shield and PGS as the sword, such that Washington is able to act preemptively. Given its lower threshold of taboo on use, Chinese analysts tend to view U.S. PGS as a threat to Beijing's conventional and nuclear weapons systems, as well as its command and control centers. With the breadth of U.S. platforms defined as PGS-related systems in China, its analysts have not ruled out their delivery of nuclear weapons. Despite its criticism of the United States, China's BMD tests in 2008 and 2010, as well as its own test moving towards PGS in 2014, show that it is seeking similar systems. If the same ideas on preemption are applied to China's own PGS, then its nuclear posture may change, whether declared or not.

- The concept of U.S. PGS in China is wide and amorphous. It includes not only boost-glide systems and terminally guided ballistic missiles that make up the U.S. PGS program, but also reusable unmanned spacecraft and unmanned scramjets. Defunct or cancelled U.S. programs are featured in Chinese technical journals, on the grounds that U.S. military programs never truly end. Even in the face of Washington's economic setbacks, Chinese analysts argue that U.S. PGS-related testing is already underway, particularly with hypersonic spacecraft. While Chinese authors tend to place PGS in the category of space weapons, they do not view it in isolation. Instead, they discuss its cyberspace and maritime application and vulnerabilities, as part of expanding cross-domain warfare research.

- Chinese strategic and technical experts are exploring a variety of countermeasures against U.S. PGS from detection technologies to interceptors, as well as C4ISR disabling electronic warfare measures. China is also developing its own hypersonic, precision-guided, boost-glide systems, with the hypersonic, boost-glide DF-21D and WU-14 as examples. With the integration of strategic analysis and planning into technical research, China's pursuit of

hypersonic and high-precision weaponry promises to be faster and more focused than that associated with its previous anti-satellite (ASAT) and BMD-related research and programs. Given how intensely Chinese analyses and programs focus on threats from the United States, it promises to be not only the driver of development, but also a primary target.

Importance for U.S. Policymakers

- Much like BMD, China's advances in the DF-21D and WU-14 are likely to be the first of more to come. Unlike BMD, they move beyond countering and copying U.S. systems towards innovation and recombination. The DF-21D is considered to be the first medium-range anti-ship ballistic missile of its kind and the WU-14—while not long-range itself—represents a potential leap in global reach, if mounted on an intercontinental ballistic missile. While the former is inherently preemptive when conventionally tipped, the latter raises questions as to whether it is intended as a conventional or nuclear form of Chinese prompt global strike. Given that U.S. PGS is regarded in China as first strike-oriented, this complicates the issue of where China's PGS pursuits are headed. With capabilities driving posture, technology-based analyses need to assume greater priority in evaluating Chinese intent.

- The tendency in China to view U.S. PGS as a weapon of preemption and to place it in a cross-domain context—with linkages to ground, sea, space, and cyberspace—may guide Chinese military doctrine toward a more assertive posture, with an emphasis on use of asymmetric capabilities early in a conflict. This would provide a new twist to Beijing's "active defense" and has begun to appear in its cyberspace research to counter Washington's PGS-related systems. In the conventional field, Chinese views on preemption with the DF-21D have their own destabilizing influence. Yet, this is even more precarious in the nuclear realm, if such views are applied to China's WU-14 development. Combined with concerns over Washington quickly, stealthily, and accurately decapitating Beijing's nuclear and conventional arsenal or command and control centers, these shifts are likely to propel China's seeking of other systems it regards as PGS, such as reusable unmanned hypersonic spacecraft and scramjets.

- Chinese technical and strategic communities are no longer as stovepiped as they once were. Divisions responsible for strategy are being merged into technical institutes, so that strategic aim, rationale, and planning evolve along with the technology and systems, rather than after them. There is also increasing cooperation among Chinese research institutes, with greater horizontal collaboration. U.S. policymakers must take into account this accelerated and integrated cycle of strategic planning and systems development. Faster-paced technological and strategic advances in weapons systems will drive future Chinese conventional and nuclear weapons policies. Understanding Chinese debates on national defense requires looking beyond simply official defense white papers to the abundant technological literature available in Chinese-language open sources. This will allow for greater advanced warning on shifts in China's future capabilities and postures.

- When evaluating the drivers behind Chinese technical and postural advances, Washington's strategic acquisition programs are viewed within Beijing not individually, but in combination and over a lengthy continuum. Yet, most Sino-U.S. strategic dialogues remain locked in a circular debate on specific systems like BMD or nuclear postures like no first use (NFU), without contextualizing them within the range of advanced conventional systems and

domains that impact Sino-U.S. strategic stability. Future bilateral dialogues could benefit from frank exchanges on the status and intended purpose of research and development programs in not only nuclear, but also the conventional realm to better determine the impact of capabilities on posture. Integration of such arenas as advanced conventional weaponry, cyber, and space into U.S.-China nuclear dialogues, as individual panels, would offer a more nuanced picture of cross-domain deterrence and the future of Sino-U.S. strategic relations.

Introduction[1]

On January 9, 2014, China succeeded in conducting a hypersonic, boost-glide test that took its regional weapons advances and thrust them onto the global stage. This test serves as a sign of China moving towards longer range, stronger retaliatory and potentially preemptive capability. It also suggests how U.S. weapons programs have played a role in serving as both a threat and a model for China. Only in the future, rather than responding to Washington, Beijing promises to engage in its own form of innovation and recombination of technology to create new game changers. This could propel China from what has historically been a more reactive (*beidong*) posture to a more active one.

For over two decades, Chinese strategic and technical communities have researched U.S. ballistic missile defense (BMD) with a mix of fascination and trepidation for its potential to exacerbate Sino-U.S. asymmetry and damage strategic stability dynamics. With the addition of prompt global strike (PGS) to this strategic lexicon, Chinese perceptions on U.S. "absolute security" (*juedui anquan*) have assumed renewed urgency and focus. The ability for Washington to conduct a preemptive strike against Beijing without fear of retaliation cuts to the heart of the concept that Washington seeks primacy at Beijing's expense. Chinese conceptual and strategic linkages between PGS and BMD are indicative of their larger concerns over the U.S. ability to deliver conventional and nuclear weapons quickly, stealthily, and accurately.

Suspicions of U.S. intent to use these systems in tandem to undermine Beijing's defenses have contributed to the speed with which China has advanced its own shield—with its BMD tests in 2008 and 2010—and its own spear—with its DF-21D development and WU-14 test in 2014. While the WU-14 reportedly depends on an intercontinental ballistic missile (ICBM) for delivery and may be considered a variant of the DF-21D, it nonetheless has intercontinental potential.[2] Thus, with China's most recent test of a hypersonic, boost-glide system, it has taken what could prove to be a significant step towards achieving its own form of prompt global strike. Given that the system could be used in a conventional or nuclear capacity, this development has the potential to re-set strategic stability dynamics between Washington and Beijing.

On the one hand, the WU-14 may enhance strategic stability by providing China's nuclear arsenal with greater survivability by undermining U.S. ballistic missile defenses. On the other hand, such a system may undermine strategic stability if Beijing's own form of PGS utilizes the same preemptive logic that Chinese experts apply to U.S. PGS-linked systems, whether conventional- or nuclear-tipped. If this is the case, it could mean not only a shift towards more assertive and preemptive behavior on the part of Beijing, but also a reevaluation of such longstanding postures as no first use.[3] To better understand these trends and their implications for Sino-U.S. strategic relations, this paper will analyze Chinese views on and efforts to counter U.S. prompt global strike, as well as steps towards developing its own.

Pairing the Spear: Chinese Views on BMD and PGS

Within China, ballistic missile defense and prompt global strike are frequently referred to in combination with the Chinese term for "conflict" or "contradiction" (*maodun*) which is comprised of the characters for shield and sword. Traditionally, Chinese use of the term in this context has leaned more heavily towards its first meaning of "conflict," with both sword and shield coming to a head. China has long decried BMD as Washington's shield, given its defense against ballistic missiles, while PGS has been seen as its spear, given its aim to conduct a precision conventional strike against any global target within an hour.[4] Beijing interprets this combination of systems as a bid by Washington to remain preemptive and untouchable.

Yet, as China's BMD tests and recent WU-14 test show, both countries are developing the "shield" and the "sword." Given that China's pursuit of PGS is reportedly aimed at defeating U.S. BMD, the second interpretation of the Chinese term *maodun* as "contradiction" is more apt.[5] China's advances in PGS may enhance strategic stability by undermining U.S. BMD, but it may also cause instability given that Chinese views on PGS as a system are rooted in lower threshold on use. Thus, the challenge to China's no first use (NFU) policy is two-fold. In terms of U.S. PGS, there remain concerns over its use against nuclear targets, even if the strike is conducted with conventional means. Beijing would have to decide whether or not to engage in nuclear retaliation to a conventional attack. This revision to Beijing's NFU posture would prioritize the intended target of the strike, instead of the weapon system used to conduct the strike. On China's own PGS pursuits, the dilemma arises from mounting hypersonic and boost-glide systems on ICBMs, which could lead to questions of conventional and nuclear differentiation, as well as preemption.

Beyond these shifts, China's advances in hypersonic, precision-guidance, and boost-glide technology already demonstrate marked changes in its research and development model. In spite of the decades of attention Beijing has paid to countering and, later, to developing its own BMD systems, the amount of Chinese technical research on related kinetic technology pales to that available on PGS-related hypersonic, precision-guidance, and boost glide systems. Of more than 2,000 Chinese-language articles unearthed on BMD written through 2011, only a third discussed underlying technologies, such as hit-to-kill or kinetic intercept. By contrast, PGS-related studies covering boost-glide and hypersonic technology exceeded 4,000 and 7,000 respectively, with precision-guidance technology reaching nearly 27,000 articles.[6] In light of the integration of technological and strategic analyses within these studies, China is engaged in increasingly rapid and coherent weapons development and deployment strategies.[7]

This research adds a new layer to a Chinese technical discourse that, heretofore, was focused more on mechanics and less on the application of any given system. Integration of strategic divisions and planning into Chinese technical research institutes is evident in three ways. First, Chinese research papers have begun to synthesize discussions strategy and foreign weapons systems into what used to be purely technology-based studies. Second, the author's own interactions with People's Liberation Army researchers confirm that such shifts are occurring. Third, these trends also emerge in scientific papers that explore China's own pursuit of boost-glide systems (rocket-launched gliders that travel in the upper atmosphere at hypersonic speeds)[8] and scramjet engine designs (variants of ramjet air breathing jet engine in which combustion takes place in supersonic airflow),[9] when discussing prompt global strike advances.

These studies demonstrate Chinese efforts to master both supersonic and hypersonic propulsion.[10] In doing so, they combine hypersonic and boost-glide technologies, when modeling trajectories with hypersonic and scramjet systems.[11] In essence, Chinese experts are seeking to recombine technologies to create new systems. Also on view is the cross-domain nature of Chinese interest, with a marked focus on development of space, maritime, and nuclear domains,[12] as well as cyber, among other means, to undermine similar U.S. systems.[13] Overall, these studies provide insights into how and why China is not only seeking to pursue similar systems and advances, but also to develop them beyond the scope of existing U.S. capabilities.

Significantly, the description of PGS-related systems within Chinese articles harkens back to much of the language used to describe the revolution in military affairs that prompted Beijing to undertake a full reassessment of its military capabilities after witnessing U.S. military dominance in the 1991 Iraq War. In fact, the whole concept of PGS—being able to rapidly and accurately hit anywhere in the world with limited warning—bears striking similarities to Chinese discussions of "informationization" (*xinxihua*), which drove Beijing's last major shift in military trajectory.[14] Such Chinese organizations as the Second Artillery Engineering College,[15] China Aerospace Science and Technology Corporation,[16] Equipment Command Technology Institute, and Department of the General Staff Corps of Engineers use the terms "revolutionary" (*geming xing*), "innovation wave" (*gexin langchao*), and "new era of military transformation" (*xin shiqi junshi zhuanxing*) to describe prompt global strike.[17]

Chinese experts further write about hypersonic, precision-guidance, and boost-glide systems in a manner that explores Washington's capabilities, while at the same time providing insights into Beijing's own technological and strategic aims in both countering and developing such technologies. In fact, the view in China of the various systems comprising the U.S. PGS program is so broad that even if the U.S. program never makes it to full deployment, prompt global strike will continue to be used within China to describe a variety of weaponry. This is hardly surprising, given the amorphous nature of U.S. PGS planning that has shifted in design from repurposed ICBMs to boost-glide systems and space planes to submarine-launched intermediate-range ballistic missiles (SLIRBMs). Chinese experts are faced with a moving target. However, no matter if this is calculated or clumsy on the part of Washington, Chinese analyses view U.S. pursuit of prompt global strike as deliberate, progressive, and tied to ballistic missile defense in achieving absolute security.

Chinese experts see the ability to counter PGS systems and develop their own as integral Beijing's ability to deter the use of coercion, whether on the battlefield or in the negotiation room. Indeed, this refrain echoes those found with China's first nuclear test in 1964, anti-satellite test in 2007, ballistic missile defense test in 2010 and 2013, and now with the WU-14 test in 2014. And it will carry into China's future advances in and tests of hypersonic, precision-guided, boost-glide systems. Thus, in China's shift from defensive countermeasures to offensive capabilities,[18] concerns over PGS relate to not simply one weapon system, but rather a host of past, present, and future U.S. prompt and precise weapons systems. This suggests that not only is PGS a crucial step in the evolution of Chinese views on future of advanced conventional warfare, it also carries implications for cross-domain warfare. Prompt global strike is fast becoming a platform that many Chinese analysts anticipate to be more pervasive and threatening than a nuclear one.

Defining the Spear: Chinese Interpretations of PGS

Not only are Chinese experts viewing PGS on a continuum of U.S. weapons advances, they also use the term "prompt global strike" in quite different ways from their U.S. counterparts. In the United States, PGS is used to refer to one particular research and development program that funds the development of long-range, hypersonic, high-precision conventional weapons. U.S. officials have often described the program's aim as the creation non-nuclear weapons capable of reaching a target anywhere in the world within an hour—although none of the technology currently receiving significant funding would actually meet this goal.[19]

For most of the administration of former U.S. president George W. Bush, PGS discussions focused on the possibility of placing non-nuclear warheads on Trident D5 sea-launched ballistic missiles and, to a lesser extent, intercontinental ballistic missiles. However, because of concerns that potential adversaries would not be able to differentiate nuclear- and conventional-tipped ballistic missiles, which would risk inadvertent escalation to nuclear war, research on boost-glide weapons subsequently moved to the fore. Most U.S. funding for the current program interest is focused on a glider known as the Advanced Hypersonic Weapon (AHW). However, the development of a new sea-launched intermediate range ballistic missile has also been discussed.

By contrast, Chinese descriptions and research into U.S. PGS include a much broader set of systems. These studies find continuity in describing U.S. PGS evolution from the Space Operations Vehicles of the 1990s—a reusable space launch vehicle[20]—through more recent programs, such as the Hypersonic Technology Vehicle-2—a global-range boost-glide system—and X-37B—an unmanned, reusable space orbiter.[21] They also remain trained on a variety of U.S. platforms,[22] such as hypersonic cruise missiles, Minutemen and Peacekeeper ICBMs, boost-glide conventional strike missiles, supersonic air-launched cruise missiles, as well as SLIRBMs.[23]

Beyond continuity, the ability of Washington to surprise with speed and precision globally via space planes appears throughout Chinese technical journals, strategic journals, and the popular press when discussing prompt global strike.[24] For example, the China Academy of Aerospace Dynamics, which is known for aerodynamic tunnel testing of missile systems,[25] writes that the U.S. space orbiter X-37B is:

> "… the first reusable hypersonic aerospace vehicle in the world, with hypersonic velocity, highly mobile orbital change and rapid response capabilities. The X-37B has broken through the thermal protection technology handicap of space vehicles, successfully demonstrating a new type of lightweight non-ablative thermal protection technology. This analysis of X-37B 'prompt global strike against targets' contains special features of thermal protection system requirements and proposed new technology for X-37B space vehicle thermal protection systems—that are lightweight, non-ablative, and will finally explore approaches for implementation of the new X-37B thermal protection technology."[26]

And even in the face of reports that Washington's PGS range might not end up being global, Chinese discussions of U.S. capabilities are. While some Chinese experts factor in a shorter striking distance for the United States' systems, they emphasize that Washington will make the most of its forward deployment with ground-based programs for high-precision surgical strikes like Forward-Based Global Strike (FBGS), as well as such companies as ATK that are viewed as capable of using their worldwide locations to quickly reach distant targets.[27] According to this view, even in the face of U.S. PGS not being deployed as a "global" system in terms of range, it will

still pose a global threat.[28]

Chinese studies cluster a range of U.S. programs as examples of ongoing efforts to achieve the same goal, namely a global-range, high-speed, high-precision, preemptive attack. Thus, despite arguments from Washington that PGS remains locked at the research and design phase,[29] the fact that such systems as the X-37B—known as the "new space weapon" (*xin taikong wuqi*) and "global strike platform" (*quanqiu daji pingtai*)—have undergone testing concretizes the idea within China that PGS is not so far away after all.[30] In fact, two researchers from the Beijing Institute of Structural and Environmental Engineering make a direct connection between PGS and U.S. pursuit of orbital planes, writing:

> "…within about a year's time, the United States carried out three types of hypersonic aircraft flight validation tests, namely X-37B, X-51A and Falcon HTV-2 (orbit planes, hypersonic cruise missiles, and hypersonic glider missiles). Aside from the X-37B, the other two types of aircraft in the flight test phase were not successful, with these two HTV-2 tests coming to nothing. DARPA [Defense Advanced Research Projects Agency] has openly stated to the outside world that it does not have a third part of its plan, will the United States really not undertake further steps? Obviously, abandonment is unlikely."[31]

This Chinese assessment is highly reminiscent of those surrounding U.S. ballistic missile defense. Even when faced with evidence of failed U.S. BMD tests, Chinese experts remain focused on the day when the systems will work to full capacity.[32] And in cases where U.S. programs are decades out of date (as with the X-20 DynaSoar) or have been cancelled (as with the Blackswift program), the tendency in China is to continue to review such programs as examples of past intent and future potential.[33] Just as with the reliable replacement warhead in the nuclear realm,[34] no U.S. program is taken as defunct or permanently cancelled.[35] China's Third Engineering Army Institute experts note:

> "With continuous improvement of its organizational mechanisms, command structure, and equipment systems, actual deployment of prompt global strike is not distant. Prompt global strike capabilities are an important part of providing the United States with an offensive combat capability, and will in the future provide the U.S. military with more options for its 'preemptive strike' strategy. With its extreme long-range precision strike, immediate arrival, mobile penetration capabilities, prompt global strike will have a significant impact on the combat theory and style of future wars, posing a new threat to international peace and regional stability."[36]

Chinese research institutes like the College of Aerospace and Materials Engineering at China's National University of Defense Technology, which focuses on design technology for satellites and rockets,[37] also provide overviews and implications of HyTech/HySET scramjet engines, as well as HyFly, Hyper-X, and HiFire programs, even when they face failed tests or budget cuts.[38] Thus, despite the fact that these articles often overestimate the levels of development and prospects of U.S. deployment of such systems, they still provide countless and highly detailed accounts of the technological capabilities, achievements, and timelines for PGS-related research, all as evidence of U.S. intentions.[39]

Fearing the Spear: Chinese Concerns About PGS

Beyond the Chinese focus on U.S. intent in developing prompt global strike, the volume of Chinese research into PGS-related systems reflects a belief that "strategic conventional weapons" (*zhanlue changgui wuqi*) are the future of warfare. While a few articles suggest that U.S. PGS systems could be used to deliver nuclear weapons, most are more preoccupied with the threat that a lowered threshold on use with PGS will enable preemptive action on the part of Washington, leading to conventional and even nuclear escalation.

The view of PGS, in tandem with BMD, as replacement weapons for nuclear weapons and nuclear deterrence took hold in China in the wake of the 2010 U.S. Nuclear Posture Review.[40] In a world in which nuclear weapons are greatly reduced or completely absent, Chinese experts argue that systems like PGS augment the level of U.S. global military dominance, since the nuclear force equalizer would be diminished or lost for countries with weaker conventional weapons capabilities. Chinese analysts are well aware of the higher potential for "strategic conventional weapons" use, as opposed to nuclear weapons, in other words conventional weapons employed for strategic or nuclear aims.

With the shift towards greater reliance on highly accurate and prompt conventional weaponry, a number of Chinese experts envision an erosion of the threshold on use that is thought by many in China to have been instrumental in staying the hand of nuclear weapons powers. Researchers from the Beijing Institute of Structural and Environmental Engineering, which has been linked to research into materials research for aerospace systems,[41] describe PGS weapons as both more useable than nuclear weapons and part of larger aims at maintaining dominance:

> "…In reality nuclear weapons cannot be used for force, and simply have become decorative. However, the United States is developing these new conventional weapons, with high combat accuracy, controlled damage range, flexible time use, and hypersonic flight (within one hour it can strike any target on the planet), [in other words] strategic conventional weapons that are easy to use and able to be used. No wonder that the United States had such a reinvigorated stance when it signed a new nuclear arms reduction treaty on April 8, 2010, since it had already in other countries' military space begun establishing new conventional strategic strike capabilities, such that it could dominate the world with military technology and military force in space. Currently, the United States is facing a transition from a nuclear to a conventional strategic strike force and will not give up just because a few test flights "fell into the Pacific."[42]

Beyond the nuclear domain, prompt global strike capabilities are part of Washington's drive towards space weaponization in the view of many Chinese analysts.[43] In particular, they fit PGS into a narrative of U.S. pursuit of "space hegemony" (*taikong zhengba*)[44] or "space weaponization and space deterrence" (*taikong wuqihua yu taikong weishe*).[45] With the establishment of the "Schriever" space wargame series conducted by the United States starting in 2001, there is little question within China as to whether or not space weaponization has begun.[46] In their view, it is already well underway. As one expert at China's National University of Defense Science and Technology, under supervision of the Ministry of National Defense and a leading institute in China's supercomputer and space programs,[47] writes:

> "…hypersonic space weapons, tactical nuclear weapons, and ballistic missile defense programs, 'three unified swords' (*san jian he yi*),[48] 'preemption' (*xian fazhi ren*) are what the U.S. military envisions as the future of warfare. (…) U.S. ballistic missile defense has been established; hypersonic space weapons that can perform 'prompt global strike' missions are already deployed. (…) 'mutually assured destruction,' as originally provided by strategic nuclear weapons, has become completely ineffective. The United States has a 'preemptive' advantage of launching the first nuclear strike, and even though other countries have nuclear weapons, this no longer equates with pulling a 'card to avoid death' (*miansi pai*) (…) The U.S. Department of Defense spared no expense on its missile defense program, has been assiduous in pursuing hypersonic space weapons, while at the same time advocating a 'world without nuclear weapons.' Clearly, the United States military has long been eyeing space."[49]

The purpose and targeting of the envisioned weapons are highly ambiguous, meaning that Chinese articles cite any number of facilities that might be at risk, including: long-range missile launch sites, military command centers, command and control capabilities, national leaders, nuclear facilities, nuclear weapons production facilities, nuclear material storage warehouses, high-value individuals, mobile missile launchers, terrorist training camps, manufacturing plants, financial supporters of international terrorism, weapons of mass destruction development programs, as well as anti-American countries or rogue states.[50]

Beyond targeting ambiguity, U.S. conventional and nuclear deterrence capabilities are increasingly merged in Chinese studies that lump PGS-type platforms in with long-range systems, tactical warfare, surveillance and reconnaissance, as a "nuclear/conventional offensive strike system" (*he/changgui jinggongxing daji xitong*).[51] Strategic effects, including on the nuclear balance, are anticipated even if the weapons delivered are not nuclear. For example, if Chinese command and control for conventional and nuclear arsenals are co-stationed,[52] this means that a U.S. strike against such facilities could have repercussions in both the conventional and the nuclear sphere.

The nature of extant U.S. capabilities in space planes, cruise missiles, boost-glide, and submarine-launched ballistic missiles suggests that no matter what form PGS takes, Chinese experts are trained upon the high-speed, high-precision, and perceived "stealth" (*yinxing*) of such systems. The inability to detect and respond to an attack until it is too late drives these concerns that feed Chinese efforts to bolster early warning. These studies show that a core concern within China is the fact that such rapid and precision strike systems can be used in a variety of venues against any number of targets. This marks a less than predictable revolution in military affairs, whether predicated upon a nuclear weapon-free world or not.

Countering the Spear: Chinese Countermeasures Against PGS

With the presumption that some U.S. PGS platforms will be deployed in spite of funding, testing, and other set-backs, Chinese analysts explore the need to develop countermeasures and similar systems. These studies emphasize that no matter the name of the program or system, such capabilities provide Washington with an unassailable triumvirate of high-speed, high-precision, and global reach. The shifting nature of U.S. prompt global strike platforms and their definitions shapes how Chinese experts are investing their technological and strategic efforts in a comprehensive and multi-vectored fashion to target a range of threats.

A variety of Chinese scientific and military institutes are seeking both strategic and technological countermeasures to target U.S. systems and programs through often cryptic descriptions of "undermining cyber linkages," "utilization of laser and microwave systems," "electronic interference," and "information countering." [53] To this end, experts at the Xi'an Branch of China Academy of Space Technology Engineering, which engages in satellite research, development, and deployment,[54] recommend cyber-networked laser weaponry—whether mounted on ground, aircraft or ships, and combined with command, control, and tracking facilities—as part of China's upgrades for contending with U.S. scramjet engine-based platforms.[55] If faced with an attack, Chinese analysts place a premium on rapid repair and recovery, as well as enhanced accuracy of tracking and interception of PGS-related systems.

In fact, China's deficiencies in early warning are a recurring theme, particularly if faced with space planes and other low orbit-based systems. Agencies like the Beijing Institute of Tracking and Communication Technology describe in great detail U.S. space-based radars as systems that both need to be countered and mastered by China.[56] These studies assert that China's own deficiencies in early warning are exacerbated by the growing "stealth" of U.S. systems and the pairing of PGS platforms with space-based capabilities.[57] A number of technical and strategic journals question whether or not China's early warning systems or ballistic missile defenses would be adequate to detect or counter a U.S. PGS attack. Most are not optimistic that Washington's boost glide and other devices would be easily subject to early detection and interception.[58]

As a result, much of the research into Chinese countermeasures focuses on a multi-layered detection and warning approach that includes infrared radiation, along with research into avalanche photodiode for early determination and detection of PGS signatures, particularly of the X-51 hypersonic cruise missile demonstrator.[59] And at least one operationally oriented military organization also appears focused on directly countering the emerging threat. Experts in the employ of the Second Artillery, the PLA's conventional and nuclear missile branch, have conducted research that anticipates the use of advanced conventional weapons against the Second Artillery's own forces.

Beyond such simulations, Chinese analyses of PGS seek to identify the weaknesses of associated systems that can be exploited to negate their effectiveness.[60] In doing so, the cyberspace domain is the newest part of this process of defining the future of warfare and fits neatly into Beijing's "informationization" (*xinxihua*) campaign that began two decades ago.[61] High-speed and high-precision are combined with C4ISR and kill capability to signal the four components necessary to fight wars of the future.[62] They do so by building upon statements from the U.S. Strategic Command and Air Force Global Strike Command, among others.[63]

The writings of such organizations as the People's Liberation Army Armaments Institute, China Aerospace Science and Industry Corporation, and Nanjing Aeronautics and Astronautics University[64] suggest that the cyber avenue for undermining U.S. PGS and other system performance will be a crucial one moving forward. Thus, despite arguments that China has not given much thought to cross-domain warfare and its connection with cyberspace,[65] the opposite appears to be the case, particularly in terms of countermeasures. Experts from China's Liberation Army Equipment Institute explore potential vulnerabilities of PGS in space and cyberspace:

> "Due to the large number, varied types, and wide distribution of prompt global strike systems and air and space information network platforms, the cross-linking of data between them is very complex. (…) Prompt global strike systems and air and space information network data linkages constitute a large system, such that the more complex the system, the weaker the links. In-depth analysis of these weaknesses, such that we may undertake targeted measures against them, is of great theoretical and practical significance. (…) It is evident that satellite systems will be the main channel for future prompt global strike combat information. Satellite systems will conduct rapid distribution of prompt global strike combat reconnaissance, surveillance intelligence, as well as transmission relay of combat command information and target indicators, and guidance navigation, etc. flight control information (…) From the perspective of satellite platforms, they have vulnerabilities in targeting and tracking, as well as kinetic energy and interference; from the perspective of satellite payload, its communication transponders are susceptible to saturation and interference, with blinding of its optical equipment by lasers, and its electronic equipment with strong interference and even burning; from the perspective of satellite and ground links, the uplink is susceptible to radiofrequency interference, light and heavy repeated attacks, and the downlink is susceptible to sidelobe (*pangban*) interference, noise interference and illegal modifications, etc. From the perspective of inter-satellite links, there exists a large transmission delay, with a large transmission path, and high signal error rates, among other shortcomings. (…) Weak links include: 1) difficulty in providing prompt global strike with timely and effective network control in the face of a rapidly changing topology of data link systems; 2) key distribution and management is easily stolen by the enemy, impacting classified information warfare, etc."[66]

This blunt description appears in just one of a number of Chinese technical studies that seek to compromise cross linkages in U.S. air and space information networks that feed satellite and other systems related to prompt global strike.[67] At a more popular level, the prolific journal *Feihang Daodan* (*Winged Missiles Journal*) advocates programs that would improve China's own network connectivity in order to both challenge U.S. systems and create its own.[68] Passive and active measures are united within these analyses, such that China's discourse of "active defense" (*jiji fangyu*) takes on an stronger offensive component. Security comes from being able to not only counter, but also to contend. Yet, as China becomes more reliant upon cyber networks for its own BMD, ASAT, PGS, and other systems, China will also be faced with future asymmetrical challenges to its own networks.

Wielding the Spear: Chinese Development of PGS

Chinese technical studies underscore that Beijing is not only looking to develop countermeasures, but also to pursue its own hypersonic, precision-guided, and boost-glide weapons.[69] Chinese analyses seek to simultaneously counter, catch up, and even surpass existing momentum and advances.[70] Given the extent of Chinese technical research into both defeating and developing hypersonic, precision-guidance, and boost-glide technology—combined with its achievements with the DF-21D and WU-14—China is already on its way.

Given the territorial disputes from the East China Sea to the South China Sea, it is not surprising that China's initial development of high-speed, high-precision, advanced conventional weapons

has been geared toward the anti-ship DF-21D medium-range ballistic missile. The DF-21D confounds the "science surprise" argument that exists among some Chinese experts, in that it is not a technology meant to simply keep apace of U.S. or other countries' technological advances. It is also not a system that is polygamous, applying to any number of military scenarios. Instead, the DF-21D targets a specific aim, namely that of anti-access/area denial (A2/AD) to hinder U.S. maritime intervention in the region.

The DF-21D marks just the beginning of hypersonic systems to counter the United States. As evidenced by the WU-14 test, China is developing such systems not simply to bolster its regional defense capabilities at home, but also to erode advantages of potential adversaries abroad, whether ballistic missile defense or other systems. Within the region, however, many in China view enhanced connectivity between the U.S. Air Force and Navy—contributing to AirSea Battle—as an impetus for it to pursue the next-generation of prompt and precise systems that are "invisible"[71] to detection and interception.

Among these, U.S. systems categorized as PGS within Chinese technical and strategic literature, such as the X-47B and X-51, are also grouped with emerging threats in the maritime domain.[72] According to the findings of a paper entitled "Establishment Optical Active and Passive Integrated Defense Systems in Naval Battle" (*Hai zhanchang guangdian zhu, beidong yitihua fangyu tixi de jianli*) by a Chinese researcher at the China Shipbuilding Industry Corporation, capabilities of concern connected with prompt global strike include:

> "…X-47B unmanned aircraft, Unmanned Carrier Launched Airborne Surveillance and Strike System (UCLASS), Long Range Anti-Ship Missiles (LRASM), Tomahawk cruise missiles, Trident submarine-launched ballistic missiles, littoral combat and joint high-speed vessels, long-range strike platforms, next-generation stealth transport aircraft, advanced missile defense radars, remote intelligent self-propelled sea mines, modular advanced armed robotic systems, ground unmanned support surrogates, as well as increased deployment of sea-and land-based Standard-3 missiles (…) Joint High Speed Vessel (JHSV) and advanced missile defense radars, remote intelligent self-propelled torpedo, the Marines advanced weapons modular robotics systems (MAARS)."[73]

At the same time, Chinese analysts frequently draw connections to other, related domains. The introduction of PGS as a U.S. technological and strategic aim has led a number of Chinese experts to add a fifth leg when discussing Sino-U.S. deterrence relations, combining space, land, sea, air, and cyberspace.[74] Prompt global strike promises to take what was once a fixed notion of warfare and deterrence within China and propel it across various domains.[75] And with its most recent WU-14 test, China has not only taken a sizeable step forward, but has done so on a potentially global scale.

If Chinese pursuit of its own form of prompt global strike is geared towards only nuclear contingencies and reinforcement of its second-strike capabilities, then it will benefit Sino-U.S. strategic stability in that it will strengthen the survivability of Chinese nuclear forces. Yet, reports that China's WU-14 has the potential to be mounted on an ICBM in the future also raise many of the criticisms and concerns that surrounded early U.S. prompt global strike development. Differentiating between nuclear and conventional contingencies will pose challenges, as will pre-existing Chinese views on prompt global strike that are tied to preemption.

Beyond this, the long shadow that U.S. developments have cast in Chinese conceptualization of their own hypersonic and other programs can be found in scientific articles dating to the early to mid-90s.[76] Nearly all of these studies make direct reference to U.S. programs as models and some of these make direct reference to China's programs, such as a study from the Beijing Institute of Systems Engineering, which fell under the former Commission for Science, Technology and Industry for National Defense[77]—considered by some to be the Chinese counterpart of U.S. Defense Advanced Research Projects Agency:

> "Our country's hypersonic testing has a good foundation, particularly the size and performance shock tunnel, free-flying (*ziyou fei*) trajectory target, arc heater scale and capabilities are not far from the international level. Currently, we should take advantage of the favorable conditions of reform and opening up (…) to take our hypersonic aerodynamic testing to a new level. Otherwise, we will not only fall behind, but the gap between our hypersonic aerodynamic testing and the advanced world will widen."[78]

Years later, these efforts have been refined and expanded in the work of such organizations as the China Aerospace Science and Industry Corporation and Beijing Aerospace Long March Science and Technology Information Research Institute that advocate Chinese development of PGS-type systems that are more "cost effective and stable" for deterrence.[79] Institutes frequently connected with hypersonic and boost glide research include the PLA Unit 92493, Northwestern Polytechnical University, Harbin Institute of Technology, Xi'an University, National University of Defense Technology, Beijing Aeronautics and Astronautics University, and the China Aerospace Science and Industry Corporation. They run the gamut from academic to operational institutes, including the China Academy of Aerospace Dynamics, China Airborne Missile Academy, and the Second Artillery.

The fact that a number of these technical studies hail from Chinese academic institutions should not be interpreted as a lack of impact on the overall pace and scale of Chinese hypersonic, boost-glide, and precision-guidance development. In fact, they signal just the opposite. A number of Chinese university professors, particularly in the sciences, play a central role in plotting out the dissertation topics of their students and often carry other affiliations. Furthermore, many of these students within such majors as engineering physics (*gongcheng wuli*), aerospace and material engineering (*hangtian yu cailiao gongcheng*), among others graduate into working within China's nuclear, missile, and other aerospace programs. Given the crossover between civil and military in all of these realms, it is difficult to confine their work into one category or one aim.

Moreover, of the Chinese studies surveyed, over a third use the term "optimize" (*youhua*) to discuss the arenas in which they can improve upon and recalibrate inefficiencies in core capabilities associated with U.S. PGS-related systems. This occurs in any number of fields, including glide capabilities of hypersonic vehicles, multiple targeting, and re-entry trajectories.[80] In particular, a premium is placed on improving control of gliding techniques using a variety of simulations and density, dynamic, and aerodynamic models.[81] A number of these studies combine their coverage of advances and wind tunnel tests of hypersonic and boost-glide capabilities.[82]

Chinese studies also integrate hypersonic and boost-glide systems, use thermal modeling and analysis to pursue infrared stealth and heat signature reductions through decoupling, and improve communication and control systems to enhance hypersonic weapon predictability.[83] This varied range of research demonstrates that Chinese experts are not simply trying to understand U.S. systems to combat them, but also how to develop, deploy, and improve upon designs for similar hypersonic cruise vehicles (HCV) and common aeropace vehicles (CAV) systems themselves.[84]

Given China's development of such systems as the DF-21D and the WU-14, this is exactly what China has done. Thus, for all of the concerns over China's potential nuclear "sprint to parity," advanced conventional high-speed, high-precision weaponry constitutes a more likely and contemporary venue for arms racing. Yet, as seen with the WU-14, the nuclear potential of these systems is never far off. Whether in strategic journals or in technical journals, both the development of and the purpose for hypersonic, precision-guidance, and boost-glide systems are merging within Chinese discourse.

This is unprecedented when compared with Chinese kinetic intercept studies of old in which the technology's use in anti-satellite or missile defense capabilities was not mentioned in scientific journals.[85] With high-precision and high-speed weaponry, the Chinese vision is becoming much clearer, much faster. Beyond speed of acquisition, the fact that nearly one-half of the Chinese studies reviewed cover long-range systems and research low-earth orbit, near space, ballistic trajectories, and reentry vehicles suggests that China's hypersonic, high-precision, boost-glide systems will also be increasingly long in range.[86]

Chinese interest in such weaponry further extends to enabling capabilities, such as intelligence, surveillance, and reconnaissance.[87] The journal *Zhongguo Hangtian* (*China Aerospace*) exhorts Beijing to make "full use of existing space-based resources, integration of military and civilian space facilities, the development of space-based information systems, coordination of planning and implementation of distributed and coordinated development, which can provide a multiplier effect."[88] Their rationale is that:

> "…with the improved accuracy of space-based navigation and positioning systems, this will simplify the process of achieving accuracy in precision guidance weaponry and in the absence of homing abilities still achieve accurate positioning. Given inadequacies in China's industrial technology base, development of high-level informationized precision strike system would offer a shortcut to a leap forward. (…) [China] should focus on breakthroughs in high-resolution satellite component technology, so that it can be used in photographic reconnaissance, electronic reconnaissance satellites, ocean surveillance satellites, and other systems."[89]

This move towards longer range systems that are embedded in a larger system of advanced C4ISR is also evidenced by studies that detail China's long-range hypersonic achievements as early as 2006.[90] Such studies are also representative of enhanced collaboration and integration of research across Chinese disciplines, departments, and research institutes, given that their authors are affiliated with Tianjin University's School of Mechanical Engineering and School of Civil Engineering, as well as Harbin Institute of Technology's School of Astronautics. This again highlights the reduction in research and development vertical stovepiping that hindered the speed, depth, and integration of strategic and technical advances.

Beyond horizontal research institute collaboration that expands creativity and connectivity, Chinese writings further describe efforts to enhance jointness in developing missile systems that can evade intercept, along with modeling and simulation for optimization of conventional missile warfare architecture to determine targets and priorities.[91] In achieving these aims, a premium is placed on improved command and control mechanisms, as well as support capabilities. Given Chinese interest in a series of other U.S. systems that include Near Space Maneuvering Vehicles (NSMV) and High Altitude Reconnaissance Vehicles (HARVe), a variety of new platforms are also likely to make their way from Chinese print into practice.[92]

Over one-fifth of the surveyed studies indicate that—with U.S. HTV-2, X-37, X-43, and X-51 variants as models—near space and low orbit unmanned spacecraft and scramjets will be next among China's developments. As a result, these types of systems are likely to be Beijing's next "spear," marking its prompt global strike aspirations.[93] This is evidenced by references to China realizing its own "hypersonic near space aircraft" (*gao chaoshengsu linjin kongjian feixingqi*) via optimization of skip-gliding, leap- and equilibrium-gliding trajectory of hypersonic near space vehicles,[94] thermal protection and thermo-mechanical coupling,[95] and the control techniques and parameters of hypersonic weaponry.[96]

Detailed dissertation research at the National University of Defense Technology into trans-atmospheric vehicle configuration that improves upon waverider configurations is just one of many studies that indicate China's high-velocity, high-precision spacecraft-oriented direction.[97] For example, one expert at China's Air Force Engineering University[98] advocates the following for China:

> "1) For low-speed near space vehicles, the emphasis is on development of key aspects of technological research, focusing on breakthroughs in key technologies.
> 2) For high-speed near space technology research, [we] should develop hypersonic aircraft, as well as related technological research as soon as possible, to enhance the performance of space vehicles, to expand the range of applications, and to provide a technical basis.
> 3) Develop research into the aerodynamic characteristics of near space, and establish a basis for control issues in near space.
> 4) Engage in research into a guidance system for near space.
> 5) Actively introduce industrial competitiveness and reform, to assist in creating a more economical near space vehicle, with a strong war-fighting capability.
> 6) Require war-fighting commanders to detail their expectations for C4ISR capabilities to be derived from near space platforms and sensors, including all short-term and long-term needs."[99]

Rather than simply representing art through imitation, these future systems are more likely to appear as new variants. This is the embodiment of the Chinese national pursuit of "innovation" (*chuangxin*), which accelerated around the same year that articles on China's long-range hypersonic achievements began to proliferate. Thus, when Chinese technological studies on hypersonic, precision-guidance, and boost-glide systems call them an "assassin's mace" (*shashou jian*), such monikers are not about a specific weapon.[100]

Instead, they represent the future of cutting-edge and game-changing technology, which China will not only seek to defeat, but also to pursue and improve. The difference is that as with the DF-21D (the first medium-range anti-ship ballistic missile of its kind), the WU-14 (a system with global reach if mounted on an ICBM), and reports that China has recently unveiled its DF-41 (the longest-range ICBM in the world), China is likely to be the country wielding the game-changers of the future.

Conclusion

Within China, ballistic missile defense and prompt global strike are labeled as the respective shield and spear of future warfare. They are part of a Chinese revolution in military affairs, as well as harbingers of greater cross-domain awareness.[101] While these two systems are often relegated to discussions of space and near space in terms of their geographical and conceptual scope, Chinese articles point to the confluence between U.S. ballistic missile defense and "cyber storm exercises" (*wangluo fengbao yanxi*) and prompt global strike and "AirSea battle" (*konghai yiti zhan*). The Chinese concept of "strategic conventional weapons" is blurring the line between China's own strategic and conventional capabilities and posture.

If there is a similar conflation of conventional and nuclear use associated with China's own BMD and PGS developments, there remain questions as to whether they will blaze a trail towards greater or less stability. As seen with their advances with the DF-21D and WU-14, Chinese hypersonic and boost-glide capabilities are rapidly spilling across various domains that include cyber, space, maritime, and nuclear arenas. As countermeasures and systems collide, Chinese advances in hypersonic, precision-guidance, and boost-glide systems are also destined to appear with increasing rapidity. Chinese technical and strategic communities are no longer as distinct as they once were, with indications that Chinese divisions responsible for strategy are being merged into technical institutes. As a result, the strategic aim, rationale, and planning for capabilities evolve along with—rather than after—the systems.[102]

Instead of a compartmentalized and staged military acquisition and modernization process, as in the past, the Chinese technological and strategic military modernization chain promises to be more integrated from the start. Chinese technical studies feature co-authors from various scientific institutes and seek to combine and optimize existing foreign and domestic designs. This indicates that China's pursuit of innovation is proceeding horizontally, as well as vertically. And it has significant implications for the speed with which military systems are researched, developed, operationalized, and deployed within China. The current level and scope of Chinese research and advances suggest that a number of assumptions made about Beijing's capabilities, posture, and intentions based on increasingly brief defense white papers must be challenged. A study of Chinese technical studies enables a view of capabilities, posture, and intent at a much earlier stage.

At the level of capabilities, the envisaged potential for U.S. BMD to undermine China's nuclear deterrent or for U.S. PGS to attack China's command and control facilities has contributed to Chinese domestic re-evaluations of capabilities and posture, with the former often driving the latter. Given the amount of Chinese research into hypersonic propulsion, boost-glide, and precision-guidance, as well as prompt and precise medium-range missiles and expanded space, maritime, and cyberspace footprints, it should not be assumed that Chinese efforts will remain regionally focused, much less simply seek to imitate or catch up to the United States. With the

WU-14 test, China broke its regional bounds with a system that merges hypersonic and boost-glide systems and is reportedly destined to be mounted on an intercontinental ballistic missile.[103] Other U.S. systems, such as the X-37B and X-51 will serve as models, but will not necessarily limit future Chinese hypersonic spacecraft and scramjet designs. China's advances are likely to show combinations of, and in some cases improvements upon, these technologies. As with the focus of AirSea Battle on the DF-21D, Washington is likely to find itself increasingly reacting to Beijing's game changers, rather than the other way around.

At the level of posture, given conceptual and strategic linkages between BMD and PGS, concerns over U.S. ability to deliver conventional or nuclear weapons quickly and accurately or to decapitate China's arsenal or command and control centers, it should not be assumed that China's NFU posture and other nuclear policies will remain immutable.[104] If these centers are co-stationed,[105] this means that a U.S. strike against such Chinese facilities could have repercussions in both the conventional and the nuclear sphere.[106] Beyond this, if China's recently tested WU-14 is deployed, it may strengthen strategic stability with the United States by increasing the survivability of China's nuclear arsenal against ballistic missile defense. However, it also raises stability questions in that Chinese strategic and technical experts tend to frame hypersonic, boost-glide weaponry as inherently preemptive. If this view crosses from the conventional to the strategic realm, then Beijing's "strategic conventional weaponry" and posture is likely to become more proactive and less "reactive."

Finally, at the level of intentions, it is essential to look beyond increasingly brief Chinese official defense white papers to review the technological literature available in open sources.[107] These studies provide empirical trend lines to better anticipate the direction China's military modernization. From longer-range hypersonic, precision-guidance, and boost-glide capabilities to its own version of prompt and precise space planes, Chinese researchers are moving ahead on optimizing what had previously been U.S. domains. It can be expected that PGS will continue to color U.S.-China interactions—including military and civilian strategic dialogues—for years to come. While this was once one sided, given Sino-U.S. asymmetries in BMD and PGS pursuits, China is now unabashedly beginning to bring both systems to the negotiation table. Utilization of similar advances to garner a greater edge to counter military coercion also occurred with China's nuclear tests in 1964, anti-satellite test in 2007, and BMD tests in 2010 and 2013. It has re-occurred with the WU-14 test in 2014 and will reappear with China's future tests of longer-range hypersonic, precision-guidance, boost-glide technology, and spacecraft.

Rather than closing off dialogue, however, Beijing's advances offer a new impetus for Sino-U.S. engagement. Strategic dialogues between China and the United States have long been relegated to the nuclear realm. In doing so, they have largely side-stepped the impact of advanced conventional technologies and dynamics. Integration of advanced conventional technologies, along with conceptual arenas like space, maritime, and cyber, into future U.S.-China nuclear dialogues, as individual panels, would offer a more nuanced picture of the cross-domain nature of deterrence and the future of Sino-U.S. strategic relations.[108] In determining the current and future subject matter of such exchanges, Chinese technical journals provide a conceptual and empirical base. Given the amount of economic and intellectual investment, combined with the integration of strategic motivation and planning into Chinese technical works, they provide insights into what China's next spear will be and where it might take aim.

[1] The author would like to express her sincere thanks to James M. Acton, George Perkovich, and Toby Dalton at the Carnegie Endowment for International Peace for their substantial comments and edits to the text. Any errors in content of those of the author alone. Original draft dated to June 2013.

[2] After the release of the following report, China's Defense Ministry and sources at the Pentagon confirmed the test. Gertz, Bill, "China Conducts First Test of New Ultra-High Speed Missile Vehicle," *The Washington Free Beacon*, January 13, 2014, available at http://freebeacon.com/china-conducts-first-test-of-new-ultra-high-speed-missile-vehicle/.

[3] In spite of protests to the contrary, Major General Yao Yunzhu alludes to the impact of systems like ballistic missile defense and prompt global strike on China's postures, including no first use, in the following essay. Major General Yao Yunzhu is affiliated with China's Academy of Military Sciences. Yao Yunzhu, "China Will Not Change Its Nuclear Policy," *China-U.S. Focus*, April 22, 2013, available at http://www.chinausfocus.com/peace-security/china-will-not-change-its-no-first-use-policy.

[4] "If the missile defense system is the future 'shield,' then the United States' is attempting through its 'prompt global strike' program to build the future 'spear.' This kind of 'absolute security' paranoia, would it make the United States more secure? [Not until] that time when U.S. missile defense system will have been established and its hypersonic space weapons will be deployed in space and able to perform 'prompt global strike' missions." Zhou Feng, "Xianfa zhiren de yanjin yu juedui anquan de pianzhi" (The Evolution of Preemption and the Paranoia of Absolute Security), *Jiefangjun bao* (*People's Liberation Army Daily*), August 15, 2007, p. 5; Wang Zhijun is affiliated with the Nanjing Army Command College and has written about U.S. pursuit of absolute security with prompt global strike as one of the indicators. Wang Zhijun, "Lun meiguo 'juedui anquan' shenxue zhengzhi yu aobama 'wuhe shijie sixiang,'" (On U.S. 'Absolute Security' Political Theology and Obama's 'Nuclear Free World' Thought) *Guoji luntan* (*International Forum*), Issue 1, January 1, 2010, pp. 17-18.

[5] Gertz, Bill, "China Conducts First Test of New Ultra-High Speed Missile Vehicle," *The Washington Free Beacon*, January 13, 2014, available at http://freebeacon.com/china-conducts-first-test-of-new-ultra-high-speed-missile-vehicle/.

[6] Among these, this paper takes a cross-section of 1,000 of the tens of thousands of Chinese articles found, covering all of those mentioning PGS, as well as a random selection of 358 articles on hypersonic and precision technology, to gain a better sense of both the strategic and technical discourse within China.

[7] Cai Lin, Wu Qian, and Lei Li are affiliated with the China Southwest Electronic Technology Institute. Cai Lin, Wu Qian, and Lei Li, "Jin kongjian gao dongtai feixingqi cekong xitong fazhan qushi fenxi" (Trend Analysis of Near Space High Dynamic Vehicle Control System Development), *Dianxun jishu* (*Telecommunications Technology*), Issue 1, January 2008, pages unavailable; Jiang Zonglin is affiliated with the Core Laboratory of High Temperature Gas Dynamics within the Institute of Mechanics and within the Hypersonic Technology Center of China's Academy of Sciences. Jiang Zonglin, "Gao chaoshengsu qidong re lixue de jige jichu yanjiu wenti" (Several Basic Research Questions for Hypersonic Aerodynamic Thermodynamics), Third Hypersonic Technology Conference, Jiangsu, Wuxi, October 2010, pp. 0048-1-0048-6.

[8] Li Yu, Cui NaiGang, and Guo Jifeng are affiliated with the Harbin Institute of Technology. "Zhutui-huaxing daodan fazhan gaikuang ji guanjian jishu fenxi" (Overview of Boost-Glide Missile Development and Analysis of Key Technologies), Harbin Institute of Technology, *Zhanshu daodan jishu* (*Tactical Missile Technology*), Issue 6, June 2008, pp. 13-19.

[9] Bai Yanlong is affiliated with the China Academy of Space Technology, Xi'an Branch of Engineering. Bai Yanlong and Baiyun, "Chaoran chongya penqi fadongji feixingqi X-51A de qiaomiao sheji" (Clever Design of the Scramjet Engine of the X-51A Aircraft), *Feihang Daodan* (*Winged Missiles Journal*), Issue 12, December 2010, pages unavailable.

[10] Supersonic propulsion is Mach 1.2–5.0, 915-3,840 mph and hypersonic propulsion is Mach 5.0-10.0, 3,840-7,680 mph.

[11] "Jiyu raodong daqi moxing de dongli tuijin gao chaosheng su feixingqi dandao texing fenxi" (Trajectories Analyse [sic.] for Hypersonic Vehicle with Scramjet Based on Pertubation Atmosphere Model), *Guofang keji daxue xuebao* (*Journal of National University of Defense Technology*), Issue 4, April 2007.

[12] Deterrence relies on a series of assumptions about how potential adversaries recognize, interpret, and react to threats of retaliation. However, if this interaction is occurring across varied spheres of conventional and strategic contention, complicated by a variety of weapons systems and domains in maritime, space, nuclear, cyber, etc. the chance of misperceptions and mistaken assumptions increases substantially. Bai Yanlong and Baiyun, "Chaoran chongya penqi fadongji feixingqi X-51A de qiaomiao sheji" (Clever Design of the Scramjet Engine of the X-51A Aircraft), *Feihang Daodan* (*Winged Missiles Journal*), Issue 12, December 2010, pages unavailable.

[13] Wu Xiaodong, Li Weimin, and Huang Renquan are affiliated with the Airforce Engineering University. Wu Xiaodong, Li Weimin, and Huang Renquan, "Gao chaoshengsu xunhang feixingqi ji qi yingdui zhanlue" (Hypersonic Cruise Vehicles and Response Strategies), *Feihang Daodan* (*Winged Missiles Journal*), Issue 2, February 2011, pp. 9-12.

[14] Zhang Chunrun, Xiong Linwei, Zhao Kun, and Liu Yadong are affiliated with the Equipment Support Department of China's Academy of Military Transport and the Department of Equipment Command and Management of China's Ordnance Engineering College. Zhang Chunrun, Xiong Linwei, Zhao Kun, and Liu Yadong, "Zhuangbei baozhang liliang peizhi xianzhuang yu duice" (Equipment Safeguards Force Configuration Status and Countermeasures), *Sichuan binggong xuebao* (*Sichuan Ordnance Journal*), Issue 9, September 2012, pp. 57-60; Lin Lin is affiliated with the Chinese People's Armed Police Force Academy. Lin Lin, "Xinxi shidai junshi renli shouji shouduan yu jishu shouji shouduan de bijiao yanjiu" (A Comparative Study of Information Age Methods of Gathering Military Intelligence Manpower and Methods of Cathering Technology), *Jichu lilun yantao* (*Basic Theory Seminar*), Issue 11, November 2012, pp. 82-84; Lu Fang and Li Xiaoquan, "U.S. Near Space Vehicles C4ISR Capabilities and Their Inspiration" (Meiguo linjin kongjian feixingqi de C4ISR nengli ji qishi), *Zhuang jiabing gongcheng xuecheng xuebao* (*Journal of the Academy of Armored Force Engineering*), Issue 3, March 2010, pages unavailable.

[15] The Second Artillery Engineering College engages in strategic missile development and falls under the Second Artillery in China, which is responsible for operationalization of China's military nuclear program. For more information in English, please see the following two sources: "Second Artillery Engineering College Creates 100-plus Generals," Ministry of National Defense, The People's Republic of China, October 20, 2009, available at http://eng.mod.gov.cn/Database/Academies/2009-10/20/content_4096563.htm; "The Second Artillery Force of the PLA," Ministry of National Defense, The People's Republic of China, date unavailable, available at http://eng.mod.gov.cn/ArmedForces/second.htm.

[16] The China Aerospace Science and Technology Corporation is the main contractor for China's space program. For more information in Chinese, please see the following link: China Aerospace Science and Technology Corporation, date unavailable, available at http://www.spacechina.com.

[17] Gao Shuanglin and Wang Fang are affiliated with the Second Artillery Engineering College Second Department and the Department of Design of the Fourth Academy of the China Aerospace Science and Technology Group respectively. Gao Shuanglin and Wang Fang, "Qipo jishu zai weilai gao chaoshengsu xunhang daodan sheji zhong de yingyong," (Use of Waverider Technology Future Hypersonic Cruise Missile Design), *Feihang Daodan* (*Winged Missiles Journal*), Issue 3, March 2007, pages unavailable; Dang Aiguo, Li Xiaojun, and Xu Bao are affiliated with the Third Research Institute of China's General Staff Corps of Engineers. Dang Aiguo, Li Xiaojun, and Xu Bao, "Waijun kuaisu quanqiu daji nengli fazhan dongtai" (Foreign Military Prompt Global Strike Capabilities Dynamic Developments), *Feihang Daodan* (*Winged Missiles Journal*), Issue 7, July

2012, pp. 51-54; Zhou Fei, "Jingque daji ji you keneng gaibian shijie junbei jingsai fangxiang" (Precision Strike is Likely to Change the Direction of the Global Arms Race), *Guofang shibao* (*National Defense Times*), January 26, 2011, p. 018.

[18] See "China's Evolution on Ballistic Missile Defense," Proliferation Analysis, Carnegie Endowment for International Peace, August 23, 2012, http://carnegieendowment.org/2012/08/23/china-s-evolution-on-ballistic-missile-defense/dkpl and Lora Saalman,"The China Factor," in Alexei Arbatov, Vladimir Dvorkin, Natalia Bubnova, Eds. *Missile Defense: Confrontation and Cooperation*, (Washington, DC: Carnegie Endowment for International Peace, April 8, 2013), http://carnegie.ru/2013/04/08/missile-defense-confrontation-and-cooperation/fyab.

[19] For more on the nature of prompt global strike, please see James M. Acton, *Silver Bullet? Asking the Right Questions About Prompt Global Strike*, (Washington, DC: Carnegie Endowment for International Peace, 2013).

[20] "Space Operations Vehicle (SOV)," *Globalsecurity.org*, accessed on December 20, 2013, available at http://www.globalsecurity.org/space/systems/sov.htm.

[21] An Hui, "Meijun taikong duidi daji jishu de fazhan" (U.S. Space-to-Ground Combat Technology Development), *Guoji taikong* (*Space International*), Issue 7, July 2010, pp. 1-7.

[22] Beyond these systems, U.S. use of unmanned aerial vehicles (UAVs) in conducting its military actions is a frequent theme in these articles. While not necessarily "prompt" in nature, UAVs are seen as providing the range, immediacy, and surprise element that concern Chinese experts. UAVs have become a marker of American preemptive intent that gives China's strategic community pause and its scientific community a challenge in combatting. If converted to a high-speed system, their effects would be even more devastating.

[23] Ye Lian, "Haozhi 800 yi, mei yao zao xin zhanlue heqianting" (Throwing in 80 Billion, the United States will Build New Nuclear Submarines), *Guofang bao* (*National Defense Report*), May 11, 2010, p. 011; "E jinggao wujiao dalou: 'Kuaisu quanqiu daji' dangxin chufa hezhan" (Russia Warns the Pentagon: Beware 'Prompt Global StrikePrompt Global Strike' will Trigger Nuclear War), *Zhongguo guofang bao* (*China National Defense News*), July 18, 2006, p. 004; Liu Xiaoen and Cao Xiuyun, "Meiguo kongjian wuqi fazhan fenxi" (Analysis of U.S. Space Weapons Development), *Zhongguo hangtian* (*China Aerospace*), Issue 5, May 2007, pp. 32-36; "Quanqiu guti huojian jishu lingdaozhe – Meiguo ATK gongsi" (Global Solid-[Fuel] Rocket Technology Leader - U.S. ATK), *Shijie bao* (*World News*), August 6, 2008, p. 015.

[24] "The X-37B space plane was successfully launched. Some people think it is the future 'space fighter aircraft' prototype. The U.S. media has said that the X-37B space plane is capable undertaking military actions against other countries' satellites and spacecraft, including control to capture or destroy their spacecraft, as well as military reconnaissance, nuclear deterrence, etc." Liu Siyan, "'X-Zhanjing' zhunbei chufa" ('X-Men' Ready to Go), *Zhongguo hangtian bao* (*China Aerospace*), February 22, 2011, p. 003.

[25] The origins of the China Academy of Aerospace Dynamics can be found in reference on page from the Policy Research Group website. "Chinese Missile Technology to Pakistan," *Policy Research Group*, June 24, 2009, available at http://policyresearchgroup.com/pakistan/289.html.

[26] Lu Qin, Jiang Guiqing, Luo Xiaoguang, and Hu Longfei are affiliated with China's Institute of Aerospace Dynamics. Lu Qin, Jiang Guiqing, Luo Xiaoguang, and Hu Longfei, "X-37B kongtian feixingqi qing zhifei shaoshi re fanghu xin jishu" (New Lightweight, Non-Ablative Thermal Protection Technology for the X-37B Space Vehicle), *Xiandai fangyu jishu* (*Modern Defense Technology*), Issue 1, February 2012, pp. 16-20.

[27] "Quanqiu guti huojian jishu lingdaozhe – Meiguo ATK gongsi" (Global Solid-[Fuel] Rocket Technology Leader - U.S. ATK), *Shijie bao* (*World News*), August 6, 2008, p. 015; Ye Zhou, "U.S. ATK Company Proposes a Land, Sea, Air "Triad" Conventional Strike Program" (Meiguo ATK gongsi tichu lu hai kong 'sanwei yiti' changgui daji fangan), *Zhangshu daodan jishu* (*Tactical Missile Technology*), July 25, 2006, pages unavailable; "Huang Wei, Luo Shibin, Liu Jun, and Wang Zhenguo, "Jiyu chengbo jishu de gao chaoshengsu xunhang feixingqi fazhan qushi yu guanli moshi" (Developmental Trend and Administrative Mode of Hypersonic Cruise Vehicle Based on Waverider Technique), *Daodan yu hangtian yunzai jishu* (*Missile and Space Vehicle*), Issue 4, April 2009, pp. 23-39.

[28] For more information, please see James M. Acton and Lora Saalman, "Conventional Prompt Global Strike and Strategic Stability," Carnegie Endowment for International Peace, February 21, 2012, available at http://carnegieendowment.org/2012/02/21/conventional-prompt-global-strike-and-strategic-stability/aq7t; Lora Saalman and James M. Acton, "China's Views on Prompt Global Strike," Carnegie Endowment for International Peace, November 14, 2013, available at http://carnegieendowment.org/2013/11/14/china-s-views-on-prompt-global-strike/gsop?reloadFlag=1.

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[30] He Qisong is affiliated with the Department of International Affairs and Public Administration of the Shanghai Institute of Politics and Law. He Qisong, "Yueshu taikong wuqihua falv jizhi de yinjing ji qi chulu" (Legal Mechanisms for Constraining Weaponization of Space and Their Outlets), *Beijing ligong daxue xuebao* (*Shehui kexueban*) (*Journal of Beijing Institute of Technology* (*Social Sciences Edition*)), Issue 5, October 2012, pp. 89-96, 127.

[31] Li Qingyuan and Shi Junhong, "Gao chaoyinsu jishu fazhan gaishu" (Overview of Hypersonic Technology Development), *Qiangdu yu huanjing* (*Structure and Environment Engineering*), Issue 5, October 2012, pp. 55-64.

[32] Lora Saalman, "China & the U.S. Nuclear Posture Review," The Carnegie Papers, Carnegie-Tsinghua Center for Global Policy, Carnegie Endowment for International Peace, Issue 2, Spring 2011, pp. 1-56.

[33] Liu Jingjing is affiliated with the China Air-to-Air Missile Academy. Liu Jingjing, "Meiguo gao chaoshengsu wuqi yanzhi xin dongxiang" (New Trends in U.S. Devemopment of Hypersonic Weapons), *Feihang Daodan* (*Winged Missiles Journal*), Issue 12, December 2012, pp. 10-13; An Hui, "Meijun taikong duidi daji jishu de fazhan" (U.S. Space-to-Ground Combat Technology Development), *Guoji taikong* (*Space International*), Issue 7, July 2010, pp. 1-7.

[34] Lora Saalman, "How Chinese Analysts View Arms Control, Disarmament, and Nuclear Deterrence after the Cold War," in Christina Hansell and William C. Potter, Eds. "Engaging China and Russia on Nuclear Disarmament," CNS Occasional Paper No. 15, James Martin Center for Nonproliferation Studies, April 2009, pp. 47-71.

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hypersonic B-3 and BX strategic stealth bombers; Falcon hypersonic aircraft; RQ-4 "Global Hawk" high-altitude, long-endurance unmanned air vehicles; XB-70 and SR-71 high speed aircraft; Hypersonic Technology Vehicles (HTV), including HTV-1, HTV-2 HTV-2A HTV-2B, HTV-3X; HL-20 simulation aircraft; adaptive trajectory reshaping and control systems (ATRC), Space Combat Aircraft (SCA) and Space Operations Vehicles (SOV); small high-precision, re-entry vehicles; aircraft defense suppression weapons; Advanced Maneuvering Reentry Vehicles (AMaRV) and High-performance Maneuvering Reentry Vehicles (HpMaRV); Roton Atmospheric Test Vehicles, Hyper-X supersonic aircraft, Hypersonic Technology scramjet engines (HyTECH); Hypersonic Flight demonstrator vehicles (HyFly); Two Stage to Orbit (TSTO) X-40 space maneuver vehicle, Trident D-5 submarine-launched missiles; Ares rapid response launch vehicle; Hypersonic Cruise Vehicles (HCV) and Common Aerospace Vehicle (CAV); hypersonic general aviation aircraft and engines; Minotaur IV Lite-launched hypersonic glide vehicles; Optimal Steady-state Cruise systems (OSC); Optimal Periodic Control Cruise systems (OPC); Rocket-Based Combined Cycle Propulsion systems (RBCC); Affordable Rapid Response Missile Demonstrators (ARRMD); Dual-Combustion Ramjets (DCR); MK41-launched hypersonic gliders; Harpoon anti-ship missiles; Standoff Land Attack Missiles (SLAM); SLAM-ER "expanded response" missile; supersonic low altitude missiles (SLAM), BGM-109C/D Tomahawk cruise missiles; F-22A Raptor fighters; JumpStart systems, Army Tactical Missile System (ATacMS); MGM-140 ATacMS solid rocket booster; Joint Standoff Weapon (JSOW); Rocket Based Combined Cycle Consortium (RBC3); High-Speed Strike Initiative Missile (HiSSM); Quickstart hypersonic vehicles; F-15, F-22A, F-35, F/A-18 equipped with hypersonic missiles; Freeflight Atmospheric Scramjet Test Technique systems (FASTT); Scramjet Engine Demonstrator Waverider (SED-WR); Ground Demonstration Engines (GDE); X-1, X-2, and SJX61-2 engines; Hypersonic Global Range Strike Aircraft (HyperSoar), Archlight Conventional Strike Missiles (CSM); Hypersonic Glider Vehicles (HGV); High Speed Reusable Flight Research Vehicle (HSRFRV); Riptide missile; ArcLight missile; Gryphon ground-launched cruise missile; Long Range Strike (LRS) platforms and stealth transport aircraft; Ground Unmanned Support Surrogates (GUSS); carrier-based, solid-state laser-light unmanned attack aircraft; Rapid Execution and Combat Targeting Systems (REACT); Propulsion System Rocket Engines (PSRE); Safety Enhanced Reentry Vehicles (SERV); as well as MK21 W-87, MK12 W62, MK12A/W78 reentry vehicles. 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[67] Ibid.

[68] Cong Min, "Jingque daji wuqi yu wangluo zhongxin zhan" (Precision Strike Weapons and Network Centric Warfare), *Feihang Daodan* (*Winged Missiles Journal*), Issue 11, November 2006, pp. 18-21.

[69] Interest in China is shifting from passive countermeasures to active ones. See "China's Evolution on Ballistic Missile Defense," Proliferation Analysis, Carnegie Endowment for International Peace, August 23, 2012, http://carnegieendowment.org/2012/08/23/china-s-evolution-on-ballistic-missile-defense/dkpl and "The China Factor," in Alexei Arbatov, Vladimir Dvorkin, Natalia Bubnova, Eds. *Missile Defense: Confrontation and Cooperation*, (Washington, DC: Carnegie Endowment for International Peace, April 8, 2013), http://carnegie.ru/2013/04/08/missile-defense-confrontation-and-cooperation/fyab. For hypersonic, boost-glide, and precision guidance related shifts, see Zhang Dongqing, Ye Lei, and Li Wenjie are affiliated with the 310th Research Institute of the Third Research Academy of the China Aerospace Science and Industry Corporation. Zhang Dongqing, Ye Lei, Li Wenjie, "2009 nian guowai gao chaoshengsu jishu fazhan gaishu" (2009 Foreign Hypersonic Technology Development Overview), *Feihang Daodan* (*Winged Missiles Journal*), Issue 9, September 2010, pages unavailable.

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[71] Yue Lianyu is affiliated with the Zhengzhou Mechanical and Electrical Engineering Institute. Yue Lianyu, "Haishang wuqi zhuangbei de yinshen jishu" (Maritime Weaponry Equipment's Stealth Technology), *Jianzai wuqi* (*Shipboard Weapons*), Issue 3, March 2002, pp. 22-29; Chen Kai, "Hai zhanchang guangdian zhu, beidong yitihua fangyu tixi de jianli" (Establishment Optical Active and Passive Integrated Defense Systems in Naval Battle), *Hai zhanchang dianzi xinxi jishu xueshu wenji* (*Proceedings of Electronic Information Technology in Naval Battlefield*), September 2011, pp. 17-19.

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[73] Chen Kai, "Hai zhanchang guangdian zhu, beidong yitihua fangyu tixi de jianli" (Establishment Optical Active and Passive Integrated Defense Systems in Naval Battle), *Hai zhanchang dianzi xinxi jishu xueshu wenji* (*Proceedings of Electronic Information Technology in Naval Battlefield*), September 2011, pp. 17-19.

[74] Dang Aiguo, Li Xiaojun, and Xu Bao, "Waijun kuaisu quanqiu daji nengli fazhan dongtai" (Foreign Military Prompt Global Strike Capabilities Dynamic Developments), *Feihang Daodan* (*Winged Missiles Journal*), Issue 7, July 2012, pp. 51-54.; "Taikong wuqihua yu taikong weishe" (*Space Weaponization and Space Deterrence*), *Guoji jishu jingji yanjiu (Studies in International Technology and Economy*), Issue 1, January 2006, pp. 24-28.

[75] Ou Nancheng, Feng Shuxing, and Cao Yuhua are affiliated with China's Liberation Army Equipment Institute. Ou Nancheng, Feng Shuxing, and Cao Yuhua, "Kuaisu quanqiu daji xitong yu kongtian xinxi wangluo shuju jiaolian shexiang" (Vision of Prompt Global Strike Systems and Air and Space Information Network Data Crosslink), *Sichuan binggong xuebao* (*Sichuan Ordnance Journal*), Issue 12, December 2011, pp. 68-72.

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[102] Based on the author's interactions with researchers from the Nanjing Army Command College.

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[105] Based on presentations and interactions at the third "Workshop on Strategic Stability and Arms Control," Carnegie Endowment for International Peace, April 12 and 13, 2013.

[106] While not an official change in policy or posture, there are indications that no first use is being debated behind closed doors within China, in part in response to advanced conventional weapons that could threaten Beijing's strategic deterrent. This observation is based on the author's exchanges with researchers of the Nanjing Army Command College, exchanges at the first and third "Workshop on Strategic Stability and Arms Control," and Yao Yunzhu, "China Will Not Change Its Nuclear Policy," *China-U.S. Focus*, April 22, 2013, available at http://www.chinausfocus.com/peace-security/china-will-not-change-its-no-first-use-policy/ in response to James Acton, "Is China Changing its Position on Nuclear Weapons," Op-Ed, *The New York Times*, April 18, 2013, available at http://www.nytimes.com/2013/04/19/opinion/is-china-changing-its-position-on-nuclear-weapons.html?_r=0.

[107] While much of the attention levied towards China's April 2013 "The Diversified Employment of China's Armed Forces" has focused on its omission of the term "no first use" and its section on arms control, greater attention should be paid to its overall reduction in content. In the past few years, China's national defense white papers have been progressively shortened from 14 sections in 2008 to 10 sections in 2010 and, finally,

to the thematically-based 5 sections under a new title in 2013. For a country that prides itself on transparency of "intent" (*yitu*)—rather than "capabilities" (*nengli*)—the content by which intent may be measured at Beijing's official level is increasingly constrained. China's new form of transparency is capabilities based. It results from Beijing's steady unveiling of new systems—from ASATs to BMD, from stealth bombers to UAVs, and from the DF-21D to the WU-14—rather than from any official document.

[108] Early inclusion of such issues would also reduce the chances of repeating what occurred in the space domain when Beijing sought space-related exchanges and was rebuffed by Washington, only to find itself in a position to reject U.S. attempts at dialogue after conducting its anti-satellite test in 2007.

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